

[0013] FIG. 2 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of the active layer of the semiconductor laser device according to the first embodiment of the present invention.

[0014] FIG. 3 is a diagram illustrating a structure for which a high-order mode equal to or higher than a first-order mode is permissible in a crystal growing direction.

[0015] FIG. 4 is a diagram illustrating a refractive index distribution and a carrier distribution along a crystal growing direction in the guide layer of the semiconductor laser device.

[0016] FIG. 5 is a diagram illustrating light confinement of the active layer when the position of the active layer is changed in the light guide layer when there is no low-refractive-index layer.

[0017] FIG. 6 is a diagram illustrating the light confinement of the active layer when the position of the active layer of the semiconductor laser device according to the first embodiment of the present invention is changed in the light guide layer.

[0018] FIG. 7 is a diagram illustrating a P-I characteristic of the semiconductor laser device according to the first embodiment of the present invention.

[0019] FIG. 8 is a cross-sectional view illustrating a semiconductor laser device according to a second embodiment of the present invention.

[0020] FIG. 9 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of the active layer of the semiconductor laser device according to the second embodiment of the present invention.

[0021] FIG. 10 is a diagram illustrating active layer positional dependency of light confinement of the active layer in the semiconductor laser device according to the second embodiment of the present invention.

[0022] FIG. 11 is a cross-sectional view illustrating a semiconductor laser device according to a third embodiment of the present invention.

[0023] FIG. 12 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of the active layer of the semiconductor laser device according to the third embodiment of the present invention.

[0024] FIG. 13 is a diagram illustrating active layer positional dependency of light confinement of the active layer of the semiconductor laser device according to the third embodiment of the present invention.

[0025] FIG. 14 is a cross-sectional view illustrating a semiconductor laser device according to a fourth embodiment of the present invention.

[0026] FIG. 15 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of an active layer of the semiconductor laser device according to the fourth embodiment of the present invention.

[0027] FIG. 16 is a diagram illustrating active layer positional dependency of light confinement of the active layer of the semiconductor laser device according to the fourth embodiment of the present invention.

[0028] FIG. 17 is a cross-sectional view illustrating a semiconductor laser device according to a fifth embodiment of the present invention.

[0029] FIG. 18 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of an active layer of the semiconductor laser device according to the fifth embodiment of the present invention.

[0030] FIG. 19 is a diagram illustrating active layer positional dependency of light confinement of the active layer of the semiconductor laser device according to the fifth embodiment of the present invention.

[0031] FIG. 20 is a cross-sectional view illustrating a semiconductor laser device according to a sixth embodiment of the present invention.

[0032] FIG. 21 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of an active layer of the semiconductor laser device according to the sixth embodiment of the present invention.

[0033] FIG. 22 is a diagram illustrating active layer positional dependency of light confinement of an active layer of the semiconductor laser device according to the sixth embodiment of the present invention.

[0034] FIG. 23 is a cross-sectional view illustrating a semiconductor laser device according to a seventh embodiment of the present invention.

[0035] FIG. 24 is a diagram illustrating a refractive index distribution along a crystal growing direction in the vicinity of an active layer of the semiconductor laser device according to the seventh embodiment of the present invention.

[0036] FIG. 25 is a diagram illustrating active layer positional dependency of light confinement of an active layer of the semiconductor laser device according to the seventh embodiment of the present invention.

[0037] FIG. 26 is a cross-sectional view illustrating a semiconductor laser device according to an eighth embodiment of the present invention.

[0038] FIG. 27 is a cross-sectional view illustrating a semiconductor laser device according to a ninth embodiment of the present invention.

[0039] FIG. 28 is a diagram illustrating an optical output power-current (P-I) characteristic of a conventional asymmetric structure in comparison with a symmetric structure.

DESCRIPTION OF EMBODIMENTS

[0040] A semiconductor laser device according to the embodiments of the present invention will be described with reference to the drawings. The same components will be denoted by the same symbols, and the repeated description thereof may be omitted.

First Embodiment

[0041] FIG. 1 is a cross-sectional view illustrating a semiconductor laser device according to a first embodiment of the present invention. An n-type AlGaAs cladding layer 2 having an Al composition ratio of 0.250 and a layer thickness of 1.5 μm is formed on an n-type GaAs substrate 1. A light guide layer 3 is formed on the n-type AlGaAs cladding layer 2.

[0042] A p-type AlGaAs cladding layer 4 having an Al composition ratio of 0.250 and a layer thickness of 1.5 μm is formed on the light guide layer 3. A p-type GaAs contact layer 5 having a layer thickness of 0.2 μm is formed on the p-type AlGaAs cladding layer 4.

[0043] A SiN film 6 having a film thickness of 0.2 μm is formed on the p-type GaAs contact layer 5. A p-type electrode 7 is formed on the SiN film 6 and electrically connected to the p-type GaAs contact layer 5 through an opening of the SiN film 6. An n-type electrode 8 is formed on a rear surface of the n-type GaAs substrate 1.